NBSIR 75-665

Point-to-Point Trip Management Program (Preliminary Analysis)

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Urban Systems Program Area

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U. S. DEPARTMENT OF COMMERCE, Frederick B. Dent, Secretary
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

PREFACE

The continuing "energy crisis" as well as the provision of new and/or expanded services by many transit properties have resulted in many people using the transit system for the first time. Many of these first-time transit users (and regular users as well) probably have experienced the major deficiency of present transit information centers -- the prompt provision of detailed trip-making information.

Trip itinerary service has been provided for many years by transit system telephone operators who scan city maps, transit system maps and schedules, and update sheets in order to identify a routing which will serve the caller's needs. Since a call for transit trip information often requires several minutes and the number of telephone requests is increasing, there is a need to shorten the operator response time in order to provide better and more telephone information service to the public.

The Point-to-Point Trip Management (PTPTM) Research Program sponsored by the UMTA Office of Research and Development is one effort aimed at improving the transit telephone information system. The PTPTM program is presently envisioned to be composed of four stages. Stage 0 is a feasibility study and initial systems analysis and engineering. Stage 1 is a research effort requiring only use of the present telephone system and off-the-shelf hardware and software capability. Stages 2 and 3 are evolutionary improvements providing better user access to the system and more effective PTPTM information processing.

Prior to undertaking this program, UMTA contracted with the National Bureau of Standards to assess the requirements for system and software development necessary for establishment of a PTPTM system. This is the final report of the portion of the contract dealing with the assessment of system requirements. The final report assessing software requirements is in the publication process.

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1. INTRODUCTION

1.1 BACKGROUND

Point-to-Point Trip Management (PTPTM) is concerned with providing prospective riders with detailed information regarding mass transit use for particular trips. As referenced in this document, PTPTM refers to a specific system concept for which the Department of Transportation Urban Mass Transit Administration (DOT-UMTA) has developed a research plan. The following description of this concept is extracted from the reference document "Point-to-Point Trip Management Description and Plan" (draft document dated May 1974).

PTPTM assistance provides explicit instructions to a prospective rider to accomplish a complete origin to destination trip using public transportation. The nearest available telephone is used to communicate the following information to the transit system:

- Where you are.
- Where you want to go.
- When you wish to arrive -- either "as soon as possible" or at a stated later time.

The transit system responds with individualized instructions telling the rider where and when to enter the system, what transfers to make, if necessary, at what times and at which stations, and where and when he will exit the system in order to arrive at his destination by the desired time. The fare necessary for the trip will also be stated.

As further described in the reference document:

"The two major elements necessary to PTPTM are the telephone system and the transit system's PTPTM Processor."

"In initial PTPTM usage only the standard telephone, with no modifications or special connections, is required to employ the telephone system element. Similarly, at the initial stage, only presently off-the-shelf data processing equipment is required for the transit system's PTPTM processor, supplemented by a semi-skilled attendant. The PTPTM processor is then partly manual operation, partly automatic operation in the initial stage.

"In subsequent stages modifications to the standard telephone may be undertaken, and certain inherent telephone control system capability more explicitly called upon to enhance the effectiveness of the telephone system element of the PTPTM. At this stage completely automatic PTPTM processor operation is accomplished, eliminating the manual requirement for the transit system's portion of the PTPTM system.

"At this stage uniformly located 'Location Posts' with public transit-system-connected telephones would provide destination locations for particular sub-areas for use in reaching parts of the urban area other than residences, or businesses. These posts, with associated numbers, would appear prominently in the transit system's 'System Map.'

"The PTPTM processor might typically contain static transit system data (bus routes and schedules...), static telephone system data (telephone line numbers with locations), and active programs synthesizing and articulating total origin to destination trips (minimum path algorithms), and supplementary digital-to-voice hardware."

The planned UMTA R&D program in PTPTM is as follows:

Stage 0 Feasibility Analysis and Program Design

This initial stage will examine the PTPTM concept in the broad sense of its overall practical potential for user acceptance and eventual implementation, as well as to analyze the particular technical and system engineering requirements of such a system concept. The detailing of R&D activity will then be based upon the needs and promise projected for this type of system. This study will be partitioned into three parts: concept feasibility, technical system analysis, and R&D program design.

Stages 1, 2, 3 Research and Demonstration

Stage 1 is a research and demonstration effort requiring only use of the present telephone system and off-the-shelf hardware and software capability. Stages 2 and 3 are evolutionary improvements providing better user access to the system and more effective PTPTM processing. In each of Stages 1, 2, and 3 a research facility development and test effort will take place, as well as limited urban demonstration.

This program was estimated to cost 2.3 million dollars over a six year period.

It was decided that further preliminary research and analysis were advisable before commencing the Stage 0 Feasibility Analysis and Program Design. This preparatory work has been designated "Pre-Stage 0 Analysis and Planning," and is the subject of this report.

1.2 PURPOSE OF REPORT

The broad task objective of this study was to assess the requirements for system development necessary for the establishment of a PTPTM system, and to develop conclusions and recommendations for future work on the PTPTM concept. Major subtasks included: reviewing present state-of-the-art, analyzing the nature of requests for information, describing and estimating benefits of recommended alternative information systems, and describing any operational augmentation which would significantly enhance the transit information function.

1.3 SCOPE

The time constraint on performing this preliminary study limited the depth to which engineering and functional detailed analyses of alternate systems could be conducted. It became evident, however, during the course of this study, that detailed work had already been performed in the context of such systems as System Development Corporation's "PARIS," which is subsequently addressed in this report. Further analysis would have been redundant and, therefore, was not considered to be cost/beneficial.

General transit trip planning information which was uncovered during the course of this study has been incorporated, even though such information is not directly related to the main thrust of the computer automated PTPTM concept.

1.4 CONTENTS OF THIS REPORT

This report is divided into five sections, including this Introduction.

Section 2 presents the results of a literature search on the subject, as well as informal discussions with people familiar with related information provision systems and the current state-of-the-art.

Section 3 deals specifically with the information collected from existing transit telephone information centers. This includes a telephone survey of 29 Transit Telephone Information Centers, on-site visits to three such centers, and information obtained from recorded tapes of actual telephone inquiries.

Section 4 contains an analysis of the information collected in Sections 2 and 3, and Section 5 presents the conclusions and recommendations of the study.

2. STATE OF THE ART

2.1 LITERATURE SEARCH

Review of literature on the subject of Mass Transit Information Systems uncovered a number of interesting publications. The Annotated Bibliography at the end of this report lists those most useful in this report, along with brief comments on their content.

As part of the literature search, the Transportation Research Information System was used via the Remote terminal at the Department of Transportation Library. The following files were searched for the keywords "TRANSIT," INFORMATION," and "SYSTEM" or "SYSTEMS:"

DOT WORK IN PROGRESS
HIGHWAY RESEARCH IN PROGRESS
HRIS ABSTRACTS
RRIS ABSTRACTS
DOT-SPONSORED NTIS REPORTS
TSC TECHNOLOGY SHARING SPECIAL FILES - NOISE
- DIAL-A-RIDE

Although the search yielded 155 hits, most of the information was not pertinent to our specific study.

2.1.1 CHARACTERISTICS OF INFORMATION CENTERS

The two reports by the Mitre Corporation, reference numbers 8 and 9, provided very useful descriptive and statistical information on how a transit telephone information center operates. Those interested in the subject should read them in their entirety, but the following summarizes the findings and recommendations of the study entitled "Transit Telephone Information Systems" (8):

° Typical transit properties receive between one and two telephone inquiries per hundred passengers carried.

° New transit systems may initially receive up to twenty inquiries per hundred passengers carried--therefore, companies should postpone establishment of permanent information centers until inquiry levels stabilize.

° Between two-thirds and three-quarters of weekday inquiries are received between 9 AM and 5 PM, and approximately 80 percent of each week's inquiries are received on Monday through Friday.

° Customers use telephone information services more if transit systems have many lengthy routes, less if transit systems are compact and have short routes.

° For the typical system, average output is 32 inquiries/clerk/hour, or 64,000 inquiries/clerk/year.

° Part-time staff should be employed during off-peak hours (e.g., evenings and weekends) to match staff levels with fluctuations in inquiry volume.

° Transit patrons ask for two types of information: advance planning information usually is requested of telephone centers; orientation information needed during travel is requested at station booths.

° Communication between customers and operators can be standardized, leading to improved customer understanding and reduction in call time.

° Interviews can be used to evaluate potential information center staff on the basis of physiological capability, personality, and work capability.

- ° Specialized training will result in better service, increased job satisfaction, and a desirable public image of the transit property.
- ° The local telephone company will provide specialized training programs for operators.
- ° Information operators should receive compensation equivalent to that of experienced clerical personnel.
- ° Telephone equipment configurations should be determined in consultation with local telephone companies.
- ° Automatic Call Distribution telephone systems, which automatically direct incoming calls to the first available information operator, contribute to efficient allocation of calls in large information systems.
- ° A recorded message requesting the customer to provide specific information is an aid to increased efficiency.
- ° Reference materials used in information centers should be designed for quick access by operators, and file access should lead directly from typical customer queries to the required reference material.
- ° Human engineering principles can be employed to improve workplace layout and will lead to an improvement in the operator's performance.
- ° Work spaces for information operators should allow common use of reference materials wherever possible.
- ° System costs vary from $0.15 to $0.30 per customer inquiry, exclusive of facility costs.
- ° A new transit telephone information system should receive extensive publicity, so that potential customers learn of its existence and how to use it.
- ° Accurate statistical data describing information system operations must be collected as a basis for continuing improvement of system operating procedures.
- ° Regional transit information systems can provide information on all transit service within the region, and furnish customers with an effective means of trip planning.
- ° In addition to telephone information centers, alternate methods of communicating transit information should be used to provide a more effective and balanced information program. Such methods include printed route maps and schedules, mass media advertisements, and display advertising and information signs.

2.1.2 TO COMPUTERIZE OR NOT TO COMPUTERIZE

In "Application of Computers to Transit Information Services" (9), Mitre concludes that computerization is likely to lead to improved service, but is <u>not</u> likely to be cost effective. Computer advantages cited include:

Consistency of performance
Reduced training time
Less reliance on individual knowledge - more on communication skills.

This report also points out that a computerized system would have obvious advantages in the trend toward centralized transit information services covering a metropolitan area and providing information on all transit modes.

A document by William Wells entitled "Public Transit Information Systems: What Level of Sophistication?" (12) bases most of its statistical information on records of the AC Transit Utility in Oakland, California, and on experiments conducted with mock operator setups. Three systems were studied. System A was a manual, hardcopy file system containing maps and schedules color coded for rapid use. System B utilized a microfiche video display with the route and schedule information on 35 mm film strips which were color coded for easy retrieval by the operator. System C was an interactive computer system with video display and light pen interaction. The resultant mean service times for these systems were 90, 80, and 60 seconds, respectively. Wells concluded that 45 seconds on the average were required for communication of request and answer, and therefore the lower bound on the mean service time is 45 seconds, regardless of the type of information retrieval system available. His cost data analysis concluded that the computer aided System C did not appear to be cost effective when compared to either the manual or the microfiche systems. The examples used to describe System C, however, indicate a much more sophisticated system than the computer system described by Mitre.

Randolph Buckley in his "Analysis and Design of a Transportation Information Center" (2) evaluated four computer systems and estimated the equivalent annualized cost of each. His conclusions closely paralleled those of Mitre, i.e., computerization is not cost-effective in terms of offering the same service as now available, but would provide better service and reduce operator training costs. Buckley also recommended: "Further study into the relationship between better information and increased ridership should precede installation of a computer system in an Information Center."

2.1.3 BETTER INFORMATION VS. INCREASED RIDERSHIP

None of the studies researched were able to establish a cause-effect relationship between better information and ridership of a transit system. Lovelock (5) concluded that: "Ignorance of transit service and faulty perceptions of transit's characteristics appear to be closely associated with non-use of public transportation." In a study at Northwestern (7), Sally Liff and Richard Michaels specifically set out to evaluate the hypothesis:

> That the ridership on mass transit
> can be influenced by improvements
> in the public information system.

They were unable to prove it on the basis of their research. "It was demonstrated that the information function does not appear to be a sensitive variable and, therefore, will not influence people or change their attitudes one way or another toward utilizing public transit."

Most studies on this subject have been part of a more general attempt to measure the effect of marketing techniques, with heavy emphasis on the effect of advertising rather than of pure informational service. Unfortunately, the quantity and kind of data necessary to arrive at reliable conclusions does not appear to exist. Transit properties which can operate "in the black" are anomalies, and it is not surprising in any financially distressed organization to find only a small percentage of the operating budget devoted to marketing services which are of questionable value.

To some extent, establishing the relationship between information and ridership is academic, since some type of information provision is necessary, and it is generally regarded as a service the transit company must provide.

2.2 RELATED AREAS - INFORMATION SERVICES

In examining the state-of-the-art, it is important to look not only at the transit industry itself, but also at related industries. To a large extent the Point-to-Point Trip Management (PTPTM) System is just an Information Retrieval (IR) system. Since other industries have been dealing with computerized IR for some time, the transit industry should try to benefit from their experience.

2.2.1 AIRLINES

Airlines have long been noted for their pioneering efforts in the field of computer applications, and most major airlines currently have fairly sophisticated reservations systems. At Eastern Airlines, the system used for disseminating information is the same one used for making flight reservations. Their Automatic Passenger Processing System (APPS) not only provides up-to-the-minute information on flight schedules, but also does ticketing and seat assignments. While there are many basic differences between the problems involved in the airline and mass transit industries, there are obvious similarities, and the airline applications currently in operation are certainly an indication of the technical feasibility of some of the PTPTM concepts.

Some of the basic differences between the two transportation modes should be kept in mind. The customer's cost of trip by transit is only a small fraction of the cost of an average plane trip. In fact, it is possible that it could cost the transit company more to tell some customer how to make a trip than the customer will be charged for the trip itself. On the other hand, the customer is more likely to repeat the trip without again having to request the additional information. Since the number of nodes or points of origin and destination of the airlines is considerably smaller than that of most transit companies, the inquiring airline customer has little difficulty specifying his origin and destination. The transit customer may have to seek information on the closest stops for origin and destinations. Furthermore, with the exception of Shuttle Flights, an airline passenger must make a reservation or he will not be able to make the trip. Most transit passengers travel without ever using the telephone information service.

However, there are similar problems in scheduling the flights and in the relationship of these schedules to information dissemination. The airline systems, at least Eastern's APPS, are very integrated. It would be difficult to separate the cost of providing information from the cost of providing schedules, making reservations, etc. It is doubtful, for example, whether seat assignment could be considered a cost effective application as a separate entity, but it is part of an overall system in which most information is available. It also provides useful information for other reports. Perhaps, it is in this area of integration that Mass Transit can best learn from the airlines' experience. Attempts at determining computer feasibility for transit information provision have not considered the cost of preparing the manual file schedules, or the side benefits of statistical marketing information.

2.2.2 TELEPHONE DIRECTORY ASSISTANCE

Another industry that deals with disseminating information via telephones is the telephone company itself. In terms of the basic elements of Transit Information Services from the user and operator standpoints, Directory Assistance by telephone operators is very similar--a Request, Research, and Report. Bell Labs performed an extensive study to evaluate possible use of microfilm or computers for directory assistance, and the resultant detailed Operator Task Analysis Call Flow Chart could be used to describe the tasks performed by transit operators. Of course, the questions are simpler and the research requirements much less complex, but the basic elements are the same. The Bell Labs' study indicated that the average time of a directory assistance call was about 33 seconds, of which approximately 1/3 is spent on each of the three elements--Request, Research, and Report. Their experiments indicated that both microfilm and computer approaches seemed viable in terms of improved service, but the economic considerations were not part of the study.

Although an extremely simple example, these same three elements are present in the process of calling for a weather report or time. The research in these cases has been done ahead of time, and all callers are requesting the same information, but these are examples that people can and do use automated telephone response.

2.2.3 RAILROADS

There are many examples of related computerization activity which lead to assurance that the technology for the full implementation of the PTPTM concept is available. For example, Japan's National Railway is implementing a system in which inquiries on the avail-

ability of tickets as well as reservations can be made from homes and offices through a pushbutton phone.*

> "This system is designed so that after calling the audio response unit at the phone reservation center on the pushbutton phone, one can enter the desired date, train name and first and last station names, according to the instructions of the audio response unit.
>
> The request is directly transmitted to the computers (two Hitac 8400s), a seat is automatically reserved in the Mars 105 and as this is being recorded in the Mars 150 reservation file, the reservation number is transmitted vocally through the pushbutton phone via the audio response unit. At the time of purchase, the reservation number is given to the window clerk who operates the terminal and issues tickets.
>
> The audio response unit of this system is the intermediary between the pushbutton phone and the central phone reservation unit. Transcribed human voice, analyzed according to word units, is recorded on a magnetic drum. It first accepts input data from the phone, then selects the words necessary for it, edits them, arranges them into a meaningful sentence and issues vocal output.
>
> Meanwhile, it edits this input data and requests a reserved seat from the central phone reservation unit from which it obtains a reply, the contents of which are again converted to voice and issued through the phone."

2.3 SDC's PASSENGER ROUTING INFORMATION SYSTEM (PARIS)

Probably the best evidence of the technical feasibility of the PTPTM concept is the fact that one company has developed a system that appears to meet the Stage 1a specifications. Using the Santa Monica Municipal Bus System as a data base, System Development Corporation (SDC) has developed an on-line system for determining best route and fare. Figure 2.1 is a sample of the output from this system. The operator keys in two pairs of street names or landmarks designating the departure location, arrival location and the time of departure or arrival. Four possible alternatives are then displayed on the CRT along with the estimated time and fare of each.

At a demonstration of this system in September 1974, SDC indicated they were making further refinements to the system and hoped to implement it in a larger city where they feel it would be cost effective.

2.4 ECONOMIC AND TECHNICAL FEASIBILITY OF PTPTM

In terms of computer state-of-the-art, the transit industry has lagged far behind most other industries. The reason, however, is not one of ignorance. The studies cited indicate that computers would not be cost-effective for information provision. Although a computerized system is currently being marketed, it has not yet found a customer willing to pay for that service.

The existence of a computer system on the market is evidence of the technical feasibility of a computer-assist system. The operation of more sophisticated systems in related industries indiate that the fully automated PTPTM concept is technically achievable.

What has not been adequately investigated, however, is the ability of the PTPTM concept to adequately serve the needs for transit information. The following sections of this report will concentrate on this, rather than on PTPTM's economic and technical feasibility.

*Computerworld, June 12, 1974.

Figure 2.1

PARIS

SAMPLE TRANSACTION

CALLER'S INQUIRY: HOW DO I GET FROM PICO BLVD. AND DOHENY DR. TO WESTWOOD VILLAGE, ARRIVING AT 9:00 ON TUESDAY?

READY... System is prepared to accept query from operator.

This is everything the operator needs to type!

pico-doheny

operator identifies the initial bus stop (naming the intersecting streets)

westwood village, 0900 w

operator identifies destination bus stop, a desired arrival time, and 'weekday'

The system outputs the best route.

```
LV  8:47 A   7(I) - AR PICO           & WESTWOOD    8:58 A
LV  9:01 A   8(O) - AR WESTWOOD       & WILSHIRE    9:07 A
                  ET  20 MIN   FARE  30
```

The best route leaves Pico & Doheny at 8:47 A.M. on bus line 7 (inbound) and arrives at the intersection of Pico Blvd. and Westwood Blvd. at 8:58 A.M. where the passenger transfers to bus line 8 (outbound) at 9:01 A.M. and reaches the destination, Westwood and Wilshire (Westwood Village), at 9:07 A.M. The elapsed time is 20 minutes and the fare is 30 cents.

```
LV  8:42 A   5(I) - AR OLYMPIC        & WESTWOOD    8:55 A
LV  9:03 A   8(O) - AR WESTWOOD       & WILSHIRE    9:08 A
                  ET. 26 MIN   FARE  30

LV  8:23 A   7(I) - AR PICO           & WESTWOOD    8:34 A
LV  8:46 A   8(O) - AR WESTWOOD       & WILSHIRE    8:52 A
                  ET  29 MIN   FARE  30

LV  8:22 A   5(I) - AR SANTA MONICA   & SAWTELLE    8:41 A
LV  8:45 A   1(O) - AR WESTWOOD       & WILSHIRE    8:53 A
                  ET  31 MIN   FARE  30
```

System gives three alternative choices

When the transaction is completed the user hits carriage return.

READY...

3. TRANSIT INFORMATION DISSEMINATION

Telephone survey was selected as the most expedient means of obtaining an assessment of the operational characteristics of transit information centers. The American Transit Association provided a report (1) which was used to select those transit systems which were surveyed. Included in this report are operational data pertaining to 87 North American transit systems, ordered according to their operating revenue.

The survey was restricted to the larger size transit systems (above $3 million annual operating revenue) because only the medium to large size transit systems have spent the necessary resources to obtain accurate statistics on the operational characteristics of their telephone information centers. Therefore, the transit systems with an annual operating revenue of over $3 million were used as the source from which 29 transit systems were contacted.

The major characteristics of the telephone information centers which were surveyed are listed in Table 3.1, in descending order by their operating revenue in 1973. Each transit system (TS) is coded so that the reader will not be biased by personal knowledge or preferences. Each of these major characteristics is discussed in greater detail in Paragraph 3.2.

Additionally, on-site visits were made to the first, fourth, and tenth largest transit systems surveyed (TS-1, TS-4, and TS-10). These visits provided valuable information on the actual operation of a telephone information center. The most valuable input to this study, however, came from TS-10. With the cooperation of managerial and supervisory personnel it was possible to obtain tape recordings of actual telephone queries and answers. A one-hour segment of the conversations of each of two operators was recorded with their knowledge and permission. In listening to these recordings one gains an appreciation of the value of good operators and an understanding of those characteristics of calls for information which may prevent the partial or total automation of a telephone information center.

The information dissemination function is a necessary ingredient in the operation of a transit system. It is discussed in this section by breaking it into two parts: general information and telephone information centers.

3.1 GENERAL INFORMATION

Most transit systems print and distribute route timetables and maps, and system maps, to the public. The route timetables and maps are commonly distributed by placing them in racks located at points of high pedestrian activity, such as banks, department stores, and shopping centers. While most timetables contain the date of initial validity, no indication is normally given as to when the timetable is out-of-date. This omission produces many calls of confirmation to the information center.

Maps of entire transit systems are relatively expensive and, therefore, not as freely distributed as timetables. Some transit systems have experimented with neighborhood timetables and maps which indicate the best way to get to areas of high activity (such as places of employment and shopping areas). These can be in the form of a one-page flyer, a pocket-size brochure, or a wallet-size card. Although it is assumed that a mass distribution of these schedules would both increase transit system ridership and decrease the number of calls to the information center, no data is presently available to support these assumptions.

Some transit systems maintain mailing lists of persons who have indicated a desire to be kept informed about changes in specific routes. New timetables are mailed automatically when a route has been changed. TS-9, TS-10, and TS-12 maintain mailing lists of 90,000, 10,000 and 50,000 names, respectively. Periodically these lists are purged by asking those who receive new timetables to indicate their continued interest. Those not responding are deleted from the list.

TS-8 achieved a 33% reduction in telephone calls by setting up a downtown information center and by undertaking to make timetables easily available to those who need them. Other transit systems also make use of the information booth concept. The information centers in TS-23 are staffed with senior citizens who are paid by United Givers Fund at no cost to the city.

Table 3.1
CHARACTERISTICS OF TELEPHONE INFORMATION CENTERS

(ORDERED BY SIZE OF TRANSIT SYSTEM)

TRANSIT SYSTEM	TYPE OF TELEPHONE SYSTEM*	NUMBER OF TELEPHONE LINES	NUMBER OF FULL TIME EQUIVALENT OPERATORS	NUMBER OF PRIME SHIFT OPERATORS	NUMBER OF CALLS ANSWERED PER WEEK	AVERAGE MINUTES PER CALL**
TS-1	ACD	60	50	30	30,000	2.7
TS-2	ACD	19	24	10	32,700	1.2
TS-3	ACD	28	24	12	36,000	1.1
TS-4	ACD	52	49	26	18,000	4.3
TS-5	switchboard	-	2	2	-	-
TS-6	ACD	78	60	30	50,000	1.9
TS-7	ACD	10	12	8	11,000	1.7
TS-8	ACD	25	17	8	20,000	1.3
TS-9	key	7	10	5	12,800	1.3
TS-10	ACD	15	20	8	20,000	1.6
TS-11	key	6	4	2	8,000	0.8
TS-12	ACD	20	25	13	20,000	2.0
TS-13	ACD	30	29	19	36,000	1.3
TS-14	ACD	18	26	10	32,000	1.3
TS-15	switchboard	-	5	5	-	-
TS-16	key	15	10	7	7,500	2.1
TS-17	switchboard	-	4	4	2,000	3.2
TS-18	ACD	20	16	8	31,700	0.8
TS-19	key	9	2	1	3,500	0.9
TS-20	key	6	6	4	7,500	1.3
TS-21	ACD	20	22	11	32,000	1.1
TS-22	key	10	5	2	7,500	1.1
TS-23	ACD	15	11	7	20,000	0.9
TS-24	key	6	6	4	3,000	3.2
TS-25	switchboard	-	8	8	-	-
TS-26	ACD	26	20	10	7,500	4.3
TS-27	key	4	4	3	8,000	0.8
TS-28	key	4	3	3	5,000	0.9
TS-29	key	3	1	1	-	-

*see the footnotes on page 12

**see discussion in 3.2.6.

Effective identification of bus stops in another primary information source. Attractive logo are used in many transit systems to make both the buses and the bus stops easily recognizable. Some people call the telephone information center to find out the location of a bus stop. A number of these calls could be eliminated by clearly identifying the bus stops so that they can be seen from a distance. Other information can also be provided at the bus stops which may reduce the number of calls for information. TS-19 has provided weatherproof containers for schedules at various bus stops. Other transit systems provide route numbers and some schedule information as part of the bus stop sign. Another useful tactic is the display of large transit maps at major transfer points.

TS-28 has developed a personalized planning service which provides trip planning through the mail in response to complex information requests received by the telephone operators. This service could be used in other information centers also, where complex requests which are received during peak hours could be answered either by mail or by telephone during less busy periods. In promoting such a service, it could be indicated that such requests may be answered immediately if the call is made during low-volume hours, say before 8AM or after 7PM.

3.2 TELEPHONE INFORMATION CENTERS

3.2.1 OPERATING PROCEDURES

No computerized telephone information center presently exists in any of the 29 transit systems surveyed. All are presently using manual procedures to answer requests for information. That is, each operator has a personal set of maps, schedules, routes, headway listings, and street directories necessary for answering information requests.

The fourth largest transit system surveyed (TS-4) is presently using three microfiche readers in addition to its predominantly manual operations. These readers each have the capability of storing and retrieving microfiche frames located in an internal revolving carousel. Once the location of the desired microfiche frame has been determined, it can be accessed by pushing appropriate buttons on the front of the viewer. No operator handling of the microfiche is necessary. The information contained on the microfiche are a detailed map of the transit system, headway sheets (including detailed schedules, route maps, and route descriptions), street locations, and indexes for easy location of specific information. TS-4 has indicated that while an experienced operator can answer requests as effectively using manual procedures as with the microfiche system, a trainee operator is able to answer requests much more effectively using microfiche. Two other transit systems (TS-1 and TS-3) have indicated they would be evaluating the use of microfiche readers for information retrieval in the near future. TS-6 had been told that their transit system was too large for efficient use of microfiche readers. They stated that they were searching for computer software which could be used with video display tubes. They ruled out the system developed by the System Development Corporation in Santa Monica, however, saying the requirement that origins and destinations be specified by either nearest street intersection or landmark was too restrictive. They stated that most requests for information use street address. The tape recording of 74 calls to the TS-10 information center did not indicate that this is universally true, however. Very few callers to TS-10 used street address as the method of specifying origin.

3.2.2 TELEPHONE SYSTEMS

About half of the telephone information centers contacted use the automatic call distributing system (ACDS).* About one-third use a key system** and the remainder channel all calls through a central switchboard. Eleven of the 14 largest systems surveyed use the ACD system. The manager associated with TS-10 indicated that the change from switchboard to ACD has resulted in a very noticeable decline in the turnover of telephone operator personnel. Job satisfaction has increased because of the impartial way in which the ACDS distributes calls.

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*Footnote is on following page.
**Footnote is on following page.

Even ACDS can cause problems, however. TS-8 reported that it had received complaints from callers who were in the hold queue for up to one hour. An indication that the problem may have been in the ACDS, itself, came from TS-10. They reported an incident where callers were in the hold queue (buttons were lighted on the master control panel) with operators being available. The ACDS did not automatically distribute the calls to the next available operator.

3.2.3 INCOMING TELEPHONE LINES

The number of telephone lines indicates the maximum number of incoming calls which can be handled (calls being answered or placed on hold) before a caller gets a busy signal. Sufficient lines should be made available so that no caller will have an overly long wait after being placed on hold. An ideal system would be large enough so that very few callers get busy signals, and such that no caller has to wait overly long.

In TS-10, about 14% of all callers hang up after being placed in the hold queue, while an additional 15% receive a busy signal when they attempt to call for information. These two groups of callers comprise what is referred to as "unanswered calls." Other transit systems are operating in a similar manner with TS-7 not being able to answer 23% of all calls, and TS-4 losing 22% of all calls. TS-18, stating that they lose 6-8% of all calls, turned out to be the most efficient system in this respect (of the seven for which percentages were obtained). A transit system may want to increase the number of incoming telephone lines in order to reduce the number of callers who get busy signals.

3.2.4 PERSONNEL

The number of full-time equivalent operators corresponds to the number of 40-hour shifts which are worked each week. A person who only works 20 hours a week, for example, would be counted as one-half of a full-time equivalent operator.

The number of prime shift operators gives an indication of how many calls can be handled at one time during peak hours before a caller is placed on hold. The maximum number of calls on hold at one time during the prime shift can be determined as the difference between the number of telephone lines and the number of prime shift operators.

Experienced, articulate, and pleasant operators are an asset to the transit systems's public relations program. To obtain such persons, TS-3 promotes qualified bus drivers to these positions, and pays them about $10,700 per year. TS-1 also fills some of its positions, from the bus driver ranks, and TS-11 uses disabled bus drivers at a slightly reduced annual wage of about $11,000. While TS-10 does not use bus drivers as telephone operators, it has been able to obtain very competent personnel by offering a starting annual wage of about $10,300 (top pay, however, is only about $400 higher).

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*ACDS (Automatic Call Distributing System): Incoming calls are distributed to the next available operator on a first-come, first-served basis. When all the operators are busy, a recorded message asks the caller to wait until an operator is free. When all lines are occupied, subsequent callers will receive a busy signal.

**Key system: A conventional telephone with the capability of handling more than one line with switching functions performed by an adjacent or attached panel of buttons, one button per line. When a call comes in, a button will light up, and an operator who is free depresses the button and processes the call. If all operators are busy when a call arrives, one operator must interrupt her conversation, answer the incoming call and put it on hold. It is also feasible to assign an extra operator the duty of simply answering overflow incoming calls and placing them on hold. When all incoming lines are occupied with calls either waiting or being processed, subsequent callers will receive a busy signal.

Owens, Vialet, and Wood (9) indicated that personnel costs account for about 95% of all costs associated with a telephone information center (the other 5% pertains to equipment rental). This figure was substantiated by the finance manager of TS-10.

3.2.5 VOLUME OF CALLS

Available data indicate that Monday is the busiest day in the week by a slight margin over each of Tuesday thru Friday. Saturday is less busy than these weekdays, and Sunday is less busy than Saturday. A best estimate of the percent of all calls received on each day is shown below.

MON	TUE	WED	THU	FRI	SAT	SUN
17%	15%	15%	15%	15%	12%	11%

These data were derived from figures supplied by TS-9, TS-14, and TS-18, from talking to TS-4 and TS-10, and from information contained in reference 9.

The peak hours of activity during a weekday were also examined. Information from TS-23 showed that 42% of their daily calls are received between the hours of 8:30 AM and 1:30 PM. The two systems for which data were available in reference 9 showed that 47% of the daily calls were received between 9:00 AM and 2:00 PM. TS-1 stated that 70% of their daily calls occur in the four-hour period between 8:30 AM and 12:30 PM. It seems safe to assume, therefore, that the peak hours of activity occur in the three hours before noon and the one hour after noon.

3.2.6 LENGTH OF CALLS

The number of full-time equivalent operators (column 4 in Table 3.1) and the number of calls answered per week (column 6 in Table 3.1) can be used to calculate an average time per call. It is assumed that each full-time equivalent operator works 40 hours (or 2400 minutes) every week. From this can be calculated the total number of operator-minutes each week. This number, in conjunction with the number of calls answered per week, is used to calculate the average minutes per call <u>if</u> every operator is continuously answering calls every minute of every hour of every working shift.

That would mean that in TS-10, for example, the 20,000 answered calls per week would average 2.4 minutes per call (20 X 40 X 60 ÷ 20,000). A more detailed look into TS-10 provided some information on the amount of time which operators are available, but are not busy because no calls are coming in. The calls handled by two TS-10 operators were recorded on a tape for a period of about one hour each. The 74 calls handled by these two operators averaged 1.6 minutes each. This would indicate that the operators in TS-10 are actively answering calls only about two-thirds of their working time (1.6 minutes actual divided by 2.4 minutes possible). This 67% activity rate was used to figure the time per call for each of the transit systems surveyed. These reduced figures for time per call, then, are shown in Table 3.1.

3.2.7 TYPE OF INQUIRIES

The tape recordings from TS-10 provided an abundance of information. The 74 calls which were recorded were on the following types*:

- requests for route and time information	66
- request for fare information	5
- request for schedule to be mailed	2
- request for lost and found information	2
- complaints	1
- calls for other transit system departments	5.

*Some of the 74 calls contained requests for more than one type of information. Therefore the sum of the types of calls is greater than 74.

The average for these calls was 1 minute and 40 seconds. The median call required 1 minute and 10 seconds. The shortest call was 8 seconds in length, and the longest call took 12 minutes and 25 seconds.

The information contained in Table 3.2 groups the 74 calls by length. An attempt was made to break each call into three parts: understanding the question, retrieving the information, and answering the question. The task was quite difficult because a large part of most calls consisted of back and forth conversations between the caller and the operator. Most callers had to have additional information drawn out of them by the operator. Additionally, answers provided to the caller seemed to stimulate requests for more information, or different information. Most calls were broken down, however, and the percentages are shown in Table 3.2. The time needed to retrieve the information was easily identified by a period of silence. Some callers received "instantaneous" information. For these calls the retrieval time was counted as zero. Back and forth conversations, where questions and answers flowed to and from both the operator and the caller, were divided such that half of the time was counted as understanding the question and half providing the answer. Several calls had more than one distinct period where the operator was retrieving information. These were added together to get one time of retrieval per call.

The operator needed to be familiar with the transit system routes so that the caller would be able to have a feeling of confidence in the information provided. Several times the operator was asked to identify the corner of the intersection where the bus would stop ("in front of the bank"), or the location of a bus stop in mid-block ("across from the car wash").

Table 3.2

ANALYSIS OF CALLS FOR INFORMATION

LENGTH OF CALL GROUPINGS (MINUTES)	NUMBER OF CALLS	PERCENT OF ALL CALLS	CUMULATIVE TIME (MINUTES)	PERCENT OF TOTAL TIME	PERCENT OF TIME REQUIRED TO:		
					UNDERSTAND QUESTION	RETRIEVE INFORMATION	ANSWER QUESTION
0:01-1:00	33	45%	19:05	15%	32%	27%	41%
1:01-2:00	26	35%	37:56	31%	29%	25%	46%
2:01-3:00	6	8%	15:24	13%	27%	31%	42%
3:01-4:00	3	4%	10:05	8%	38%	30%	32%
4:01-5:00	2	3%	8:30	7%	39%	22%	39%
over 5:00	4	5%	31:47	26%	32%	39%	29%
TOTAL	74	100%	122:47	100%	31% average	27% average	42% average

4. ANALYSIS OF FINDINGS

4.1 GENERAL INFORMATION

The primary objective of PTPTM is to provide information to people for efficient use of public transportation. A telephone information system is just one method of achieving that objective. As a general policy, most transit companies correctly regard it as one of the more expensive methods. They, therefore, try to reduce the telephone demand by providing information via other means - distribution of schedules, maps, etc. Although no data on cost of producing and distributing printed material was gathered, the approach seems valid and should be encouraged. However, it would appear that some of these techniques are not as effective as they might be.

Paragraph 3.1 pointed out that there are many calls in which the caller had a schedule readily available, but wanted confirmation that it was still effective. It would seem useful, therefore, that schedules contain a time span (e.g., March 1, 1974 to September 1, 1974) for which they are effective, and be updated on a preplanned and regular basis.

Some of the maps examined were extremely difficult to understand, particularly when they show numerous routes passing through a downtown area, including route differences between peak and non-peak hours. It would appear that, in the interests of economy, the map-makers attempted to get as much information as possible on one piece of paper, with too little regard for the user's understanding of the information presented. The specialized neighborhood schedules, with a brief map indicating only the streets travelled, appear to be more effective.

The other methods of general information provision cited in 3.1, appear to be effective, though we have no data to measure their effectiveness. Although TS-8 claimed a 33% reduction in telephone calls by setting up a downtown information center and making timetables more readily available, the cost of operating that downtown center was not furnished.

For the most part, the information dissemination function appears to be regarded as a centralized function. Perhaps more emphasis should be placed on decentralization. Two factors that would indicate the merit of this approach are:

1. Other industries, besides the transit industry itself, can benefit from good information on public transportation,

2. Most people get personal satisfaction from relaying information they have.

Restaurants, theatres, and other places of public entertainment are examples of industries that can benefit from disseminating information on the availability of public transportation. When advertising, they should be encouraged to indicate which transit lines serve their location. Housing developments, particularly planned communities, can use the information as a selling feature. Schools and places of business should be happy to provide information on public transportation to students and employees.

Most people have had the experience of asking in a small group for information concerning a transit trip. A common result is that too many people try to talk at once. People are proud of their knowledge, and are happy to disseminate it whenever possible. Although difficult to exploit, it would seem that more effort should be expended to examine ways to tap this resource.

4.2 TELEPHONE INFORMATION CENTERS - CURRENT PROCEDURES

There is a wide variance in the characteristics of telephone information centers. While the information gathered from the telephone survey generally supports the conclusions of the cited Mitre studies, it did not indicate any relationship between number of inquiries and passengers carried. There does not appear to be a "typical" transit information center.

The 29 telephone information centers which were contacted are ordered by size of the transit system in Table 3.1. While the annual operating revenue for these transit systems ranged from $186 million to $3 million, the operating characteristics of the telephone information centers are not dependent on the size of the transit system. For example, the telephone information centers in TS-2 ($100 million) and TS-21 ($6.4 million) have similar operating characteristics. This would indicate that some factors other than transit system size have major influence on the operational characteristics of a telephone information center. While these influencing factors have not been rigorously determined in this study, certain logical assumptions can be made. Those factors which may have such an influence are:

- stability vs. recent reorganization of a transit system
- publication vs. lack of publication of the information center telephone number
- adequate vs. inadequate telephone equipment (telephone lines, operator stations, etc.)
- availability vs. lack of availability of information by other means (information booths and timetable racks at strategic locations, free and useful transit maps, etc.)
- a dense vs. a spread out transit system
- experienced vs. novice telephone operators.

The Automatic Call Distributing System (ACDS) is used in most centers averaging 20,000 or more calls per week and with 8 or more operators. Although one of these centers reported complaints of callers being held in queue for up to one hour, this does not seem likely if the ACD system is operating properly. On an ACD first-come, first-served basis, 8 operators would have to be averaging over 30 minutes per call in order not to be able to handle the 15 calls in queue at any given time.

There is a wide difference in the average length of the calls, from a low of .8 minutes in several of the centers to 4.3 in two of the centers. Since on-site visits to all centers were not conducted, the available data does not indicate any apparent reasons for the differences. It apparently has nothing to do with the size of the system itself. One can only speculate that factors, such as experience of operators, complexity of route structure, and management of personnel might be contributing factors.

It was interesting to note that the few centers which had readily available information on the number of calls per operator per shift experienced relatively low average lengths of calls (0.8, 1.1, and 1.3). This would seem to indicate that letting personnel know they are measured and are expected to maintain reasonable standards has a positive effect on productivity.

Table 3.2 indicates that a large percentage (31%) of the total time of a call is spent in understanding the question. If the caller's questions were well formulated, it could save the operator from having to draw out necessary information. The recorded message provided in ACD systems should, therefore, encourage the caller to be prepared to give origin, destination, and approximate time of travel.

4.3 OPERATOR - ASSIST COMPUTER RETRIEVAL SYSTEMS

Both the literature search and the analysis of the tape recordings from TS-10, indicate that retrieval of information typically represents less than one-third the length of the entire call. Most of the operator time is spent in communications. Therefore, a computer retrieval system that still required an operator would have marginal effect on productivity.

Even if it is assumed that a marginal decrease in the average length of call could be effected, it should not automatically be assumed that operators would then be able to handle a proportionately larger increase in calls. Human factors studies would be beneficial in this area, however, no existing studies on this subject are available.

Introducing a computer for retrieval would add two additional elements of translation into the existing system. The question must not only be translated from customer to operator, but also from operator to computer and vice versa.

After witnessing a presentation on the "Paris" system by Systems Development Corporation, an analyst, familiar with terminal operations and completely at ease "talking with computers," listened to the tapes of actual questions posed to a transit company.* This was done with the intention of determining how much time could be saved by a computer-assisted system in an actual situation. The analyst found the exercise almost impossible to do because so few of the questions were presented with sufficient data for input to the computer system. It would have been necessary for the operator to ask for more information. Often, this need for additional information was required in the present manual system, but not nearly as often as one might expect. The majority of callers knew the name of the bus line and how to get into the transit system, so it was often not necessary to pinpoint a specific origin. In some cases, the caller was unsure of the exact location and required assistance from the operator, who had to refer to a map for help. In other cases, the destination was referred to as "the three hundred block of Main." There were often questions on how many blocks away the stop was, and in some cases this was the determining factor in whether or not bother with a transfer. The operator was often asked to describe the identifying sign on the bus, and this usually included both a number and a name. There were very few cases in which the caller had the option of more than one route. This did not seem to bother the caller, who seemed primarily interested in any way that worked within his time frame.

The caller can learn to present his questions in a manner which would ease the computer translation problem. As pointed out in 4.2, efficiency would undoubtedly be improved if people put on hold would receive a recorded message asking them to please be prepared to give the origin, destination, and planned time of day of the trip in question. This practice is currently being carried out at some installations.

Some type of map display is almost a necessity for some kinds of questions. While computer-produced maps are technically feasible, this capability would be very expensive to maintain as well as install. Even with this feature, it is unlikely that any computer-retrieval system would completely obviate the need for manual reference materials.

4.4 AUTOMATIC COMPUTER SYSTEMS

Currently there is no available information on the cost of providing the manual research material that operators use. As in the airlines' more integrated systems, it is conceivable that an integrated system which would be used for other related transit operations might be cost-effective. However, as a separate operation, computerization of transit information retrieval does not appear practical.

A completely automated system eliminates the need for operator intervention. However, it would necessitate teaching the customer to use a telephone system for which he must have reference material (codes for identification of origin and destination). It should be kept in mind that the telephone information centers, for the most part, were set up for people who did not know how to use a particular system (the transit system itself, e.g. buses) and/or did not have, or know how to use, the reference material on that system (schedules, route maps, etc.). It is possible that training and provision of easy-to-use reference material on the transit system itself may not be significantly more difficult than providing the same training and reference materials for the use of the automated system.

Regarding the suggestion that questions be structured, it is not unusual for people to reject the idea of structuring in manual systems, but accept them in computer systems because "that's the way it has to be." The fact that the computer ignores "back-talk" can be an advantage over manual systems.

As with an operator-assisted computer system, it appears that some operators would still be required for certain types of questions. Since operator salary and training costs represent the major expense of a telephone information center, a major reduction in operator work force would be necessary for the automated system to be cost-effective.

*See 3.2.7 for more information on these tapes.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

- There is no evidence that a direct cause-effect relationship exists between transit information dissemination and transit system use.
- No transit system is presently using a computer to support its telephone information center operations.
- The primary problem of telephone information centers is "lost calls" (the number of callers whose attempt to make contact with a transit information operator is unsuccessful).
- Most callers appear satisfied with the routing given and do not request route options.
- The number of calls to a telephone information center can be reduced by more effective dissemination of general information.
- Transit system size does not have a major influence on the operational characteristics of a telephone information center.
- Making operators aware that they are being measured and are expected to maintain reasonable standards of performance has a positive effect on productivity.
- No documentation presently exists on the cost and benefits of using microfiche in telephone information centers.
- In discussing feasibility of computerized PTPTM, it is important to distinguish between an operator-oriented computer retrieval system and a completely automated system which does not require operator intervention.
- Operator-assisted computer retrieval systems solely for telephone information centers, while technically feasible, would not be cost-effective.
- Even a substantial reduction in retrieval time would not justify the cost of any computer system unless staffing requirements are also reduced.
- Computer retrieval systems which do not require operator intervention (completely automated) are technically feasible but would still require some operators to handle questions which do not conform to the structure required by the automated system.
- A completely automated system, which substantially reduces the need for human operators, may be cost-effective in a telephone information center which has high operating costs for training and salaries of operators.
- The major problem in implementing a completely automated system would be training the public to accept and use it.

5.2 RECOMMENDATIONS

Based on the above conclusions, the following recommendations are proposed. Some are related to the general field of Point-to-Point Trip Management, whereas others are related to the PTPTM research plan of DOT-UMTA.

- A study to measure the effectiveness of various methods of general information provision (other than telephone).

- Systems analysis of existing procedures at Transit Information Centers, concentrating on the more effective use of the communication time between customer and operator (as opposed to time reduction for retrieval of information).

- Documentation and analysis of experience with microfiche on those systems which now use or plan to use this media.

- Suspension of further development of operator-assisted computer-retrieval systems until PARIS has been evaluated for
  - a) operational costs, and
  - b) ability to adequately handle different types of calls.

- Feasibility study of totally automated computer systems to determine:
  - a) adequacy to handle most types of customer inquiries,
  - b) requirements for training customers in its use,
  - c) public acceptance,
  - d) costs for equipment, software, data base creation, and data base maintenance, and
  - e) staffing requirements and costs including operators, and computer analysts, programmers, and operators.

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   An update of the marketing progress that has been made in the 10 years since Dr. Lewis M. Schneider's study in 1962. Forty-one transit systems are examined in regard to the extent of their marketing activity. While improvements in marketing awareness were found, the average expenditure for marketing had not changed. The decision to create or expand the marketing role had occured more frequently in medium and small, rather than large, transit systems.

7. National Urban League and Mark Battle Associates, Inc., Marketing Techniques and the Mass Transit System, July 1973.

   Identified marketing and information techniques being used sucessfully to increase patronage. Also developed a model for evaluating transit information and marketing systems and for increasing their effectiveness. The study describes the efforts of five cities to confront transit problems. Recommended improved information on vehicles, at stops, and at stations to increase ridership. Statistical analysis did not support the hypothesis that greater promotional effort would result in increased income and ridership.

8. Owen, Catherine S. and Vialet, John L., Transit Telephone Information Systems, Mitre Corporation, March 1973.

While intended to be a guide for transit properties considering the establishment of a transportation information service, this report is also useful to transit agencies that wish to evaluate the effectiveness of existing transit information systems. The report begins with an analysis of system requirements and data on representative system operating costs. Included are recommendations for system inauguration and maintenance, a discussion of the operation of regional transit information systems, and a discussion of the alternative methods of information distribution being used in order to minimize the use of telephone information retrieval.

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A telephone information service is used by many transit companies to provide information to the public on routes, schedules, and fares. The operation of a number of transit telephone information services has been investigated to determine whether the introduction of computer systems would lead to an increase in efficiency. It is concluded that a computer system would not be cost effective; but that the standard of service would be raised if one were introduced into the information system.

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Determined the effect of route and schedule information and advertising on transit ridership. Several pages are devoted to a study of 431 callers. Included is a frequency chart of call purposes.

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Examined 12 U.S. transit systems and their marketing practices. Weaknesses were cited, including poor product planning, unwillingness to invest in market research and extensive promotion, and the failure to market a high quality service to appeal to the more affluent segments of the traveling public. Recommended improving service by use of air conditioning, and developing marketing strategies for different classes or riders.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This preliminary analysis of Point-To-Point Trip Management (PTPTM) was prepared for the Urban Mass Transit Administration in Washington, D.C. PTPTM is concerned with providing prospective riders of mass transit with the necessary detailed information for particular trips. This report contains the results of a literature search on automation in the telephone information center, and analyzes the data collected from 29 existing centers. Additionally, on-site visits were made to three operational centers, and tapes of actual telephone inquiries and responses were obtained and analyzed. The use of microfiche and computers are examined as an aid to the operators in these centers. Total automation of these centers is also discussed. Conclusions and recommendations for further study in this area, and an annotated bibliography, are also part of this report.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Computers; Information systems; Mass transportation; Telephone systems

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